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EMERGING SMART TECHNOLOGY FOR SUSTAINABLE DEVELOPMENT

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Abstract

Stress Global climate action is essential for achieving Sustainable Development like good health, well-being, clean water, sanitation, etc and equality in countries.
Global warming has caused Earth's surface temperature to rise about 0.8 degrees Celsius over the last 100 years. Ocean acidification is swelling, ice sheets are shrinking and sea levels are rising twice as quickly as when the last century, causing widespread coastal flooding; severe weather (droughts in some areas, storms in others); and major threats to agriculture and natural ecosystems.
Scientists believe that in the coming forty years, the earth's surface will appear very different if climate change is not regulated down. The consequences of these changes are unpredictable.
Smart technologies with IoT, machine learning and AI provide energy optimization with more reliable Operational practices to reduce consumption, reducing CO2 emission, also, encouraging greener energy production through Renewable energy, low waste production and recycling of waste for further use with Zero Emission.
Within the framework, we will propose various smart tech IoT devices, Intelligent Robotics, Smart City plans, etc. based on the 3 R (Reduce, Reuse and Recycle) concept for sustainable development. Eventually, we state, how to bring these concepts into real-time practice.

INTRODUCTION

In 1999, Kevin Ashton, the co-founder of the Auto-ID Center at the Massachusetts Institute of Technology (MIT), first mentioned the internet of things in a presentation made to Procter & Gamble (P&G). Introducing radio frequency identification (RFID) to P&G's senior management, Ashton called his presentation "Internet of Things" referencing the hottest trend of 1999: the internet. In 1999, the book by MIT professor Neil Gershenfeld, When Things Start to Think, did not use the exact term but provided a vision of the future of IoT.
IoT has evolved from the convergence of wireless technologies, microelectromechanical systems and the internet. The convergence has helped tear down the silos between operational technology (OT) and information technology (IT), enabling unstructured machine-generated data to be analyzed for insights to drive improvements.
The first internet appliance was a Coke machine at Carnegie Mellon University in the early 1980s. Using the web, programmers could check the status of the machine and determine if a cold drink would be waiting for them if they visited the machine.
IoT evolved from M2M communication, i.e. machines connected to each other via a network without human interaction. M2M refers to connecting a device to the cloud, managing it and collecting data.
IoT is a sensor network of billions of smart devices that collects and shares data by connecting people, systems, and applications. As its foundation, M2M offers the connectivity that enables IoT.

Internet of Things (IoT)
IoT is a giant network of "things", which can be human, non-human, machines, devices, or any other natural or man-made object that can be assigned an IP address and can communicate over a network. The relationship is between people-people, people-things and things-things. IoT collects and shares data with an on and off switch to the Internet (and/or to each other).
This includes everything from cell phones, coffee makers, washing machines, headphones, lamps, wearable devices and almost everything you can think of. This also pertains to components of machines, for example, a jet engine of an airplane or the drill of an oil rig.

An IoT ecosystem consists of web-enabled smart devices that use embedded systems, such as processors, sensors and communication hardware, to collect, send and act on data they acquire from their environments. IoT devices share the sensor data they collect by connecting to an IoT gateway or other edge device where data is either cloud analyzed or locally analyzed. Sometimes, these devices communicate with other related devices and act on the information they get from one another. The devices do most of the work without human intervention, although people can interact with the devices -- for instance, to set them up, give them instructions or access the data. The connectivity, networking and communication protocols used with these web-enabled devices largely depend on the specific IoT applications deployed.
IoT can also make use of artificial intelligence (AI) and machine learning to make data collecting processes easier and dynamic.

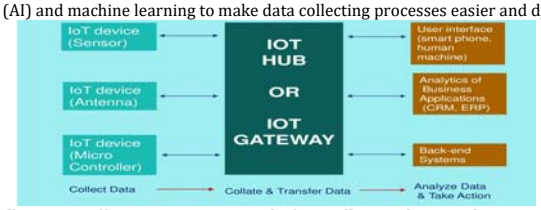

Illustration of how an IoT system works from collecting data to taking action.

IoT innovations in sustainable development
SAP analysis shows the IoT's potential in significantly saving carbon emissions. In an official analysis of the European Commission dated November 2018, the Internet of Things was named a *transition enabler* in how buildings, appliances and the energy systems of buildings can be synchronized to optimize energy flows and reduce emissions. Once fully operational, IoT has been projected to reduce global carbon emissions by around 20%.
Energy
As a major driver of accountability, the energy sector is looking for ways to make amends and reduce carbon impact. IoT facilitates automated maintenance and reporting, data collection, analytics, and optimizing smart grids. IoT sensors reduce energy consumption, generate renewable energy on-site, and measure carbon consumption plus waste. A recent report has revealed that 'smart' measures in the energy sector have been projected to result in saving more than 2 billion metric tons of carbon dioxide per annum.
At-home IoT applications like these give more visibility into energy consumption as well as the impacts due to minor changes. Through this, individuals are equipped with the resources that help them adopt a more sustainable lifestyle.
IoT Smart Grids for Energy Management
According to a report conducted by the UN in 2015, the world's population will boost to 9.7 billion by 2050. As the population rises rapidly, more people transmigrate

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to urban areas and thus introduce challenges in providing energy to billions across the globe.
The current grid systems, are inefficient and expensive. Smart Grids allow two-way communication between energy providers and customers as well as transmission line monitoring. This flow of information enables quick responses to real-time changes in electricity demand or power distributions, resulting in efficient energy allocation.
Here are a few scenarios where Smart Grids can provide efficiency and reduction of energy waste compared to conventional grid systems:

- Automatically reroute during power disturbances, which minimizes damage for a quicker time to resolution
- Contain large-scale blackouts by triggering mechanisms to isolate outages
- Allow electricity recovery strategically, like providing power to emergency services first
- Adjust outputs automatically based on usage data across geographic regions
- Reduce the peak load on distribution feeders

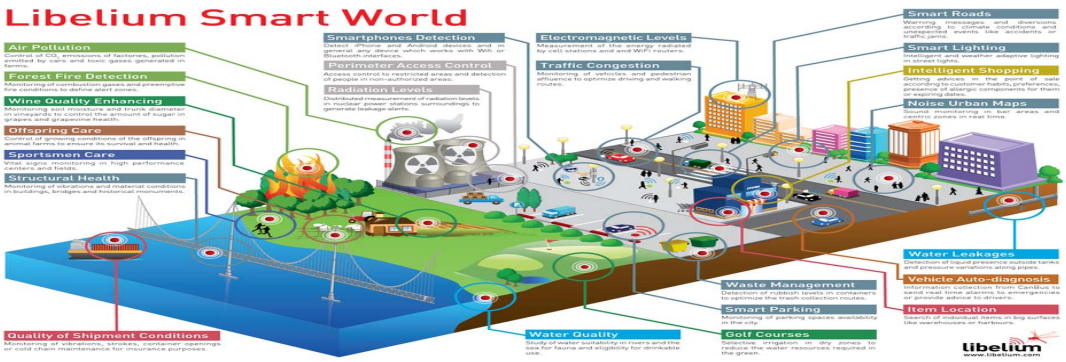
The green IoT space is rich in opportunities, both from a business point of view and the potential for making a positive environmental impact.
IoT Powered Precision agriculture
IoT-powered precision agriculture can be another facilitator of change. Data-driven agriculture highlights the main idea of more production and low waste. IoT is already in action for monitoring crops and soil conditions, screening farm animals and reducing greenhouse gases. Irrigation is also at stake. Agriculture accounts for 90% of global water consumption, making water scarcity a concern. IoT-enabled irrigation systems optimize water consumption and minimize waste.
IoT sensors connected to watering systems measure climatic parameters like humidity, temperature, and soil moisture. This data can then trigger automatic smart irrigation.
IoT to reduce food waste
Climate change is primarily caused by food waste, which has a greater carbon footprint than aviation. IoT can help to address these issues by reducing emissions related to food waste by 6-8%.
IoT for Post-Harvest Analytics**:** Inadequate temperature control is the primary cause of spoilage of fresh food. IoT sensors embedded in pallets of freshly harvested food are paired with cloud-based analytics to collect data and trigger alerts when pallets need to be cooled. Data from the journey along the supply chain is analyzed to pinpoint inefficiencies in the process that contribute to this premature spoilage so that they can be prevented in the future.
IoT Food Container Tags to Prevent Waste: Smart home speakers to notify when the food in their fridges needs to be consumed.
IoT for Green Roof Maintenance
Besides being aesthetically pleasing urban greenery significantly reduces air pollution, absorbs carbon dioxide, and prevents floods. Many large cities have supported this trend.
Industrial IoT (IIoT)
Industrial IoT (IIoT) uses cyber-physical systems to monitor the physical factory processes and make data-based automated decisions. While IoT makes physical systems intelligent, real-time communication and cooperation with humans are established via the wireless web.
IIoT brings in the concept of a digital factory.

- Digital/connected factory: IoT-enabled machinery can transmit operational information to original equipment manufacturers and field engineers.
- Facility management: The use of IoT sensors in manufacturing equipment enables condition-based maintenance alerts.
- Production flow monitoring: IoT in manufacturing can enable the monitoring of production lines starting from the refining process down to the packaging.
- Inventory management: IoT applications permit the monitoring of events across a supply chain.
- Plant Safety and Security: IoT combined with big data analysis can improve workspace security in the plant.
- Quality control: IoT sensors collect aggregate product data and other third-party syndicated data from various stages of a product cycle.
- Packaging Optimization: By using IoT sensors in products and packaging, manufacturers can gain insights into the usage patterns and handling of the product from multiple customers.

IIoT application has given tremendous business transformation with Optimization of power, energy and waste reduction.
IIoT Powered Maritime cargo shipping
Cargo ships transport 90% of the goods traded globally by volume, including oil, electronics, clothing, and food. Oceanic cargo shipping consumes roughly 300 million tons of dirty fuel per year, resulting in 949 million tonnes of carbon dioxide. The shipping industry leads to nearly 3% of carbon emissions worldwide. Early adoption of IoT monitoring and rerouting for cargo shipping can reduce fuel consumption by 15%. With IoT applications, predictive maintenance can avoid week-long overhauls and facilitate timely repairs. This will extend the life of existing fleets and minimize the need for fleet rejuvenation.
Smart City
A smart city is an urban area that uses different electronic methods and sensors to collect data. Insights gained from that data are used to manage assets, resources and services efficiently. This includes data collected from citizens, devices, buildings and assets that is then processed and analysed to monitor traffic and transportation, power plants, utilities, water supply networks, waste, crime detection, information systems, schools, hospitals, and other community services.
The smart city concept integrates information and communication technology (ICT) and various physical devices connected to the IoT network to optimize city operations and connect to citizens.
Intelligent autonomous cars can usher in a new era of green driving by allowing cars on the road to communicate and process what other vehicles are about to do. This allows traffic to move in a pattern, reducing the fuel inefficiency by the speed and gear shifts in human-operated vehicles.
Intelligent Robotics
Climate change needs to be checked more crucially today and Technologies such as IoT, AI and machine learning have become intelligent tools to fight climate change. The use of robotics for sustainability can help us fight climate change.
A variety of robots are already being developed that can help preserve the environment by fighting wildfires, helping manage waste and clean oceans. Intelligent robots can help automate and carry out environment-friendly tasks with utmost efficiency without tiring.
Applications of robotics for sustainability:

- Fighting wildfire
- Connected wildlife
- Waste management,
- Restoring oceans,
- Renewal energy

5 Fighting Wildfires
6 Recent years have marked an increase in wildfires, causing extensive damage to plants, animal species, human health and infrastructure. Robots can help control wildfires quickly and avoid risking the lives of firefighters. Robots equipped with fire extinguishers, water propelling agents, GPS technologies, heat sensors, AI and computer vision can help mitigate wildfires. These technologies can enable efficient fire detection and extinguish remotely.
7 These robots can be used in areas highly inaccessible to humans or areas with high risks. Robots having robotic arms and camera sensors can be used in search and rescue operations. These robots not only can carry out human procedures efficiently but also help save human lives.



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Connected wildlife

With the help of intelligent robots, Scientists and wildlife experts can re-established the species. IoT has been used to bring species back from the brink of extinction, with great success. The Iberian Lynx was re-established in Spain after using IoT technologies to track and monitor the few remaining wild lynxes.

Waste management

Waste generated by humans must be managed and disposed of in an eco-friendly manner. Robots are already in use to perform basic chores such as vacuuming, cleaning, mowing, and sorting garbage. Household waste collection can be carried out by GPS and AI-enabled garbage collection robots. These robots can also collect data from sensors, and AI algorithms can determine the optimal garbage collection route and process. Thus, the process of garbage collection is streamlined, resulting in minimum use of resources. Automating the processes involved in waste management and waste treatment can help reduce CO2 emissions associated with these procedures. Robots can help reduce waste by efficiently and rapidly sorting materials that can be recycled and put to use again.

Restoring ocean health

Human activities, industrial effluents, oil drilling, etc. have caused significant damage to water bodies. Oil and gas activities are a major cause of water pollution, and this was evident from the BP oil spill in 2010. Robots can prevent the harmful effects of such spills. A robot already has been designed that ingests microbes in the ocean and converts it into energy. The robot can operate continuously for months and can generate more energy than it consumes. Such robots can also help remove chemicals from water bodies. The only current limitation of such robots is that they aren't made of biodegradable materials. Efforts are made to design robots of completely biodegradable materials so they don't have any negative impact on the environment.

Robots can be used for waste collection from water bodies. Plastic waste can be collected by robots floating on the water bodies or can even be deployed on the ocean floor to collect waste from the depths. Robots can be proved cost and time-efficient in waste collection. Hence, their deployment will gain prominence in the upcoming years.

Renewable energy sector

The adoption of renewable energy sources like solar and wind energy is gaining tremendous momentum. Robots can help simplify the processes involved in renewable energy generation, especially in solar energy sources. The power output of solar cells depends upon the solar energy that reaches the surface of the solar cells. The environment is one of the major factors that determine whether the cells will return maximum yield. Dust on the cells can result in less output. The dust needs to be cleaned continuously, especially for solar farms located in high dust-density regions such as Africa or South Asia. Robots can automate the task of cleaning the solar panels whenever the dust layer over the cells passes permissible levels, ensuring that the solar panels can provide maximum output. Another beneficial application of robots in the solar energy sector includes a robot with built-in solar panels. This robot can generate its electricity while carrying out tasks assigned such as monitoring or cleaning without any external source of energy.

Sustainable agriculture

Intelligent Robots can make agriculture more environmentally friendly. By analyzing the data, the optimum levels of fertilizers, whether chemical or natural, can be determined for maximum productivity. Other robots can be used to automate tasks such as planting, sowing, watering and crop harvesting. Robots attached with sensors and computer vision can determine the optimum time for picking up fruits and vegetables. This approach could help the farming world reduce waste and increase energy efficiency making it more Sustainable.

Robots can also be used for livestock farming, for instance, where they can be used for milking cows or managing a herd of domesticated animals.

CONCLUSIONS

Climate change is a major issue for the world, and global warming is already leading to the displacement of entire communities, extreme weather events, and the destruction of ecosystems.

The study provides a pervasive review of emerging smart technology IoT, machine learning and AI and its application to IoT devices, Industrial IoT Smart devices, Intelligent Robotics, Smart City, etc for Sustainable Development. Applications based on emerging smart technology focuses on enhancing energy efficiency or reduce global emissions across agriculture, transportation and many other industries, empowering our way to a healthy future. Eventually, we deliver the verity on how to implement these concepts in the real World.

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REFERENCES

Alexander S. Gillis .*Internet of things (IoT).* Retrieved Aug 7, 2021 from https://internetofthingsagenda.techtarget.com/definition/Internet-of-Things-IoT

Internet of things (IoT). *Electronic resources.* Retrieved Aug 7, 2021 from https://www.record-evolution.de/en/iot-and-sustainability-the-environmental-impact-of-the-internet-of-things

Internet of Things[info graphic] .Retrieved Aug 7, 2021 from https://www.tutorialandexample.com/wp-content/uploads/2020/01/what-is-iot-1.png

IoT Gateway [info graphic] .Retrieved Aug 7, 2021 from https://www.magrabbit.com/storage/app/media/blog/IoT2.jpg

Jacob Morgan. . *A Simple Explanation Of 'The Internet Of Things'*. .Retrieved Aug 7, 2021 from https://www.forbes.com/sites/jacobmorgan/2014/05/13/simple-explanation-internet-things-that-anyone-can- understand/?sh=62b41c701d09

Libelium Smart world [info graphic] .Retrieved Aug 7, 2021 from https://thumbor.forbes.com/thumbor/960x0/https%3A%2F%2Fblogs-images.forbes.com%2Fjacobmorgan%2Ffiles%2F2014%2F05%2Flibelium_smart_world_infographic_big.jpg

Smart City. *Electronic resources.* Retrieved Aug 7, 2021 from https://en.wikipedia.org/wiki/Smart_city

Smart City. *Electronic resources.* Retrieved Aug 7, 2021 from https://smartcities.gov.in

Sustainable Agriculture [info graphic] .Retrieved Aug 7, 2021 from https://copanational.org/sites/copanational.org/wp-content/uploads/2020/08/Drone-Scan.jpg